APPLICATION UNDER UNITED STATES PATENT LAWS

Atty. Dkt. No. PM 0272981
(M#)

Invention: VOICE-CONTROLLED NAVIGATION DEVICE UTILIZING WIRELESS DATA TRANSMISSION FOR OBTAINING MAPS AND REAL-TIME OVERLAY INFORMATION

Inventor (s): WIENER, Christopher

Pillsbury Madison & Sutro LLP
Intellectual Property Group
1100 New York Avenue, NW
Ninth Floor
Washington, DC 20005-3918
Attorneys
Telephone: (202) 861-3000

This is a:

☐ Provisional Application

☒ Regular Utility Application

☐ Continuing Application
☐ The contents of the parent are incorporated by reference

☐ PCT National Phase Application

☐ Design Application

☐ Reissue Application

☐ Plant Application

☐ Substitute Specification
Sub. Spec Filed ____________
in App. No. ____/________

☐ Marked up Specification re
Sub. Spec. filed ____________
In App. No ____/________

SPECIFICATION

VOICE-CONTROLLED NAVIGATION DEVICE UTILIZING WIRELESS DATA TRANSMISSION FOR OBTAINING MAPS AND REAL-TIME OVERLAY INFORMATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to navigation systems. Specifically, this invention relates to a novel system and method that promotes safety in, and enhances the utility of, navigation systems.

2. Description of Related Art and General Background

Navigation systems assist users in finding their way from one location to another. In some systems, a user inputs a starting location and an intended destination, and the system, typically via algorithms acting on map databases, generates a sequence of directions that the user may follow to successfully reach the destination. These directions comprise one or more waypoints, which are points along the prescribed route that may bear significance to the route. For instance, if the directions prescribe that the user should turn right at the intersection of X and Y Streets, then that intersection may be a waypoint. In such systems, a user traversing the route must carefully follow the directions. Indeed, if the user veers off the route, the user easily may become lost; in unfamiliar surroundings, it is often difficult to return to the prescribed route.

More advanced systems employ Global Positioning System (GPS) technology to supply a user in close vicinity of the navigation device with real-time information about the user's geographic location. A GPS-equipped device receives signals transmitted by twenty-four NAVSTAR GPS satellites orbiting the earth, triangulates these signals, and

computes the location of the device in terms of coordinates. Because the coordinates are themselves of little significance to most users, GPS systems may provide a visual representation of a user's location, represented by a cursor overlaid on a map of the region in which the user is presently located.

Hybrid systems combine the functionality of the above-described systems. A user inputs a desired destination, a GPS receiver in the navigation device computes the current location of the device, software determines a route for the user, and the device outputs a set of directions for the user to follow. A map of the surroundings encompassing the route may be shown on a video display, as may the current location of the device. The current location may be represented by a cursor overlaid on the map. Additionally, the prescribed route may be superimposed on the map. Both the map and cursor may be dynamically updated as the user traverses the route. Nevertheless, if the user fails to constantly monitor the position of the cursor on the map, the user may not realize that he has deviated from the prescribed route. When this discovery is made, significant travel time may have been lost, and a less advantageous route may be the only alternative.

When users travel across great distances or vacation in obscure locales, navigation devices must display maps associated therewith. Accordingly, large data sets are needed. Most conventional navigation systems have relied on mass-storage means, such as CD-ROMs, to fulfill this need, but many region-specific CD-ROMs must be purchased at great expense. The map information contained within the CD-ROMs may become outdated with the construction of new thoroughfares. In addition, the map information may become unreliable when, for instance, temporary road construction, traffic conditions, or natural disasters render legs of a route inaccessible or otherwise undesirable. Various solutions have been proposed, including acquiring map data from remote locations via radio

transmission or similar means. Unfortunately, these proposals fail to sufficiently limit the character, quantity, and frequency of transmissions from the remote location to the user's location and back.

More fundamentally, these proposals are lacking in their failure to sufficiently protect the well-being of the user. In particular, when a user inadvertently deviates from a prescribed route, the user may be inconvenienced by travel delays. Further, at night, the likelihood of having an accident may increase if the user has ventured onto secondary roads in need of repair or roads in which lighting is inadequate.

Moreover, the problem of the misguided traveler exists alongside an even more pervasive one: the problem of the distracted traveler. For example, when the GPS device resides in a car, a driver who is lost may have to physically input new commands, such as a request to generate a new route from the current position to the original destination. By physically operating the device when driving, the driver may become distracted, making such operations potentially dangerous.

Furthermore, it is desirable that those in the public-at-large, including persons with disabilities, are able to fully avail themselves of the functionality of a navigation system.

Therefore, what is needed is a system and method that promotes safety in, and enhances the utility of, navigation systems.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts a high-level diagram of a navigation system in accordance with an embodiment of the present invention.

FIG. 2 depicts a functional block diagram of a subscriber unit in accordance with an embodiment of the present invention.

FIG. 3 illustrates the architecture of a subscriber unit, constructed and operative in accordance with an embodiment of the present invention.

FIG. 4 illustrates the architecture of a service provider, constructed and operative in accordance with an embodiment of the present invention.

FIGS. 5 and 6 are high-level flow diagrams depicting a method of navigation in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

The following detailed description refers to the accompanying drawings that illustrate embodiments of the present invention. Other embodiments are possible and modifications may be made to the embodiments without departing from the spirit and scope of the invention. Therefore, the following detailed description is not meant to limit the invention. Rather, the scope of the invention is defined by the appended claims.

It will be apparent to one of ordinary skill in the art that the embodiments as described below may be implemented in many different embodiments of software, firmware, and hardware in the entities illustrated in the figures. The actual software code or specialized control hardware used to implement the present invention is not limiting of the present invention. Thus, the operation and behavior of the embodiments will be described without specific reference to the actual software code or specialized hardware components. The absence of such specific references is feasible because it is clearly understood that artisans of ordinary skill would be able to design software and control

hardware to implement the embodiments of the present invention based on the description herein.

Moreover, the processes associated with the presented embodiments may be stored in any storage device, such as, for example, a computer system (non-volatile) memory, an optical disk, magnetic tape, or magnetic disk. Furthermore, the processes may be programmed when the computer system is manufactured or via a computer-readable medium at a later date. Such a medium may include any of the forms listed above with respect to storage devices and may further include, for example, a carrier wave modulated, or otherwise manipulated, to convey instructions that can be read, demodulated/decoded and executed by a computer.

A navigation system, as described herein, includes a subscriber unit configured to receive and transmit navigation information, as well as other service-related information. The subscriber unit incorporates a speech processing mechanism to accommodate communications between the subscriber unit and a subscriber, and global positioning technology to determine the subscriber's current position. A service provider communicates with the subscriber unit, and is configured to receive and transmit information. As such, the subscriber unit and service provider exchange information. The service provider may provide the subscriber with real-time map and routing information, and may alert and reroute the subscriber if the subscriber becomes lost.

FIG. 1 is a high-level representation of navigation system **100** in accordance with an embodiment of the present invention. As shown, navigation system **100** comprises subscriber unit **35**, service provider **31**, cellular communications network **32**, and various cellular data transmitters **34**. Subscriber unit **35** is the navigation device of navigation system **100**, and is operated by a subscriber in need of navigating to a desired destination.

Subscriber unit **35** transmits the subscriber's current position and desired destination to service provider **31**, and requests that service provider **31** provide a map and directions to assist the subscriber in navigating from the current position to the desired destination. Service provider **31** performs information gathering and processing functions, as well as transmits real-time navigation information to subscriber unit **35**. In the embodiment of FIG. 1, communication between subscriber unit **35** and service provider **31** is effectuated by cellular communications network **32** and its subsidiary cellular data transmitter sites **34**. It is to be appreciated that other modes of communication may link subscriber unit **35** and service provider **31**, such as radio broadcast transmissions.

In an exemplary implementation, service provider **31** has a direct connection to a data communications network, such as, for example, the Internet **36,** and a connection to various third-party information providers **37**. Thus, service provider **31** may access a host of information, processing such information and transmitting it to subscriber unit **35**.

It may be desirable for a subscriber of navigation system **100** to enter into an account relationship with service provider **31**. Accordingly, a subscriber may open an account with service provider **31**, and provide information to service provider **31** that identifies the subscriber as distinct from other subscribers. In addition, service provider **31** may precisely tailor the services it offers to the subscriber. In an exemplary embodiment, each subscriber is designated with a user identifier that subscriber unit **35** embeds in each data packet transmitted to service provider **31**.

FIG. 2 is a functional block diagram depicting subscriber unit **35**. Subscriber unit **35** may be designed for installation in a vehicle such as a car or helicopter, receiving power from the vehicle's electrical system. In some embodiments, subscriber unit **35** may be packaged in a compact form such that a person traveling by foot, for example, a hiker

or a tourist in a city, may carry the device, which may be outfitted with a rechargeable power supply. In other embodiments, subscriber unit **35** may be mounted on a wheelchair or similar personal transportation device, such as a bicycle or golf cart, whereby the operator may navigate to an intended destination. Subscriber unit **35** may also be incorporated into a communications device, such as, for example, a cellular phone.

As shown, subscriber unit **35** comprises GPS antenna **41**, GPS modules **42**, encryption and decryption modules **43**, wireless data antenna **45**, wireless data modules **44**, speech processing modules **46**, and central processing, storage, and service modules **47**. Input device **48** and output device **49** may be integrated into various modules of subscriber unit **35**, or may be provided in navigation system **100** as peripheral devices.

In particular, GPS antenna **41** and GPS modules **42** constantly acquire the coordinates of a subscriber's current position on earth. Wireless data antenna **45** and wireless data modules **44** transmit data to, and receive data from, service provider **31** over the cellular communications network **32**. Encryption and decryption modules **43** encrypt and decrypt information exchanged between subscriber unit **35** and service provider **31** to safeguard the subscriber's privacy. Speech processing modules **46** receive and process verbal requests conveyed by the subscriber, such as a request to navigate to a specified destination. After subscriber unit **35** transmits the subscriber's request to service provider **31,** service provider **31** gathers map information that the subscriber needs in order to navigate from a current position to the specified destination, and transmits that information to subscriber unit **35**. Central processing, storage, and service modules **47** process the received map information, which may be outputted via speech processing modules **46** in the form of speech and via output device **49** in the form of graphics and text.

FIG. 3 illustrates an exemplary implementation of subscriber unit **35**. As shown, subscriber unit **35** includes a number of modules that interact to perform the requisite navigation functions. These modules are grouped into functional blocks that correspond to those shown in FIG. 2. These modules may be incorporated in a single chipset, or in separate devices that are interconnected. Software or hardware implementations of various modules may be adopted at the option of those skilled in the art.

Cellular antenna **45** and cellular data transceiver **70** receive data from, and transmit signals to, service provider **31**. During reception, cellular data transceiver **70** supplies the data signals to data transceiver **71**, which converts the data signals into a data format suitable for processing by subscriber unit **35**. During transmission, data transceiver **71** modulates the data into data signals suitable for transmitting across a cellular communications network **32**.

Encryption/decryption processor **72** decrypts data received from service provider **31**, as well as encrypts data before subscriber unit **35** transmits it to service provider **31**.

Transmit message generator **73** processes messages to be communicated to service provider **31**. In an exemplary implementation, transmit message generator **73** processes (1) messages containing service requests for new map information, whereby a subscriber can continue to navigate in a new locale; (2) position update messages, whereby subscriber unit **35** updates service provider **31** with the current position of subscriber unit **35**; (3) message receive acknowledgements, whereby subscriber unit **35** confirms with service provider **31** that subscriber unit **35** has received messages sent by service provider **31**; (4) retransmit requests, whereby subscriber unit **35** requests service provider **31** to retransmit data; and (5) messages indicating subscriber unit **35** has been activated or

deactivated. Each message processed by transmit generator **73** contains the subscriber's user identifier.

Received message handler **74** processes decrypted messages received from service provider **31** and dispatches them to appropriate service modules in subscriber unit **35**. Received message handler **74** detects when a message has been received by subscriber unit **35** and validates such message. If the message is invalid, received message handler **74** initiates a retransmit request and supplies the request to transmit message generator **73** in order to generate a retransmit request to service provider **31**.

As indicated in FIG. 3, subscriber unit **35** is also equipped with a GPS antenna **41** and GPS receiver **77**, which constantly receive current position information from GPS satellites orbiting the earth. Such position information may be formatted, for example, as a NMEA 0183 data stream. Position information parser **78** parses the data stream outputted by GPS receiver **77**, extracting current position information and converting it in accordance with the data format of subscriber unit **35**.

Position difference correlator **75** receives inputs from received message handler **74**, from central processing and data storage unit **76**, and from position information parser **78**. In order to minimize the quantity of cellular data transmissions in navigation system **100**, subscriber unit **35** need not constantly update service provider **31** with the current position of subscriber unit **35**. Instead, service provider **31** may store a current position of subscriber unit **35**, and subscriber unit **35** may also store the current position in nonvolatile memory. Position difference correlator **75** compares the actual current position of subscriber unit **35**, as provided by GPS receiver **77** and position information parser **78**, with the current position stored in service provider **31**. When the difference between the actual current position and the current position stored in service provider **31** exceeds a

threshold value, subscriber unit **35** transmits a position update message to service provider **31** containing the actual current position of subscriber unit **35**.

Position difference correlator **75** also compares the actual current position of subscriber unit **35**, as provided by GPS receiver **77** and position information parser **78**, with a position related to one or more points along a route that a subscriber is traversing. In one embodiment, position difference correlator determines the perpendicular distance between the actual current position and a line connecting a previous waypoint and the next waypoint of the route. When the distance exceeds a predetermined value, signifying that a subscriber has likely inadvertently strayed from the route, position difference correlator **75**, transmit message generator **73**, and central processing and data storage unit **76** may act in concert to take appropriate action, including notifying the subscriber or transmitting a request to service provider **31** to devise an alternative route for the subscriber to traverse.

In another embodiment, a route is divided into a series of segments, each of which includes a starting and an ending position lying on the route. For curved roads, the segments may comprise short distances. For a given segment of the route, after the subscriber begins to traverse the segment, position difference correlator **75** may determine the distance between the actual current position of the subscriber and the segment. When the distance exceeds a predetermined value, the system may respond as described above. It is to be understood that if service provider **31** maintains a sufficiently current record of the position of subscriber unit **35**, service provider **31** may also monitor whether the subscriber has strayed from the prescribed route.

Central processing and data storage unit **76** stores current position information in nonvolatile memory, commands that have been sent to service provider **31**, current map information, and encryption keys. As such, subscriber unit **35** always has a resident copy

of map information corresponding to the geographic region in which subscriber unit **35** is currently located, and may retransmit commands to service provider **31** if an error occurred during transmission. Central processing and data storage unit **76** also controls, monitors, and interfaces with transmit message generator **73**, encryption/decryption processor **72**, position difference correlator **75**, map data parser **79**, display generation unit **80**, speech synthesis unit **82**, and speech command processor **84**.

Map information received from service provider **31** and routed by central processing and data storage unit **76** to map data parser **79** may be represented in terms of geographical coordinates, and comprises specific coordinate locations corresponding to waypoints along a prescribed route. Map data parser **79** converts this map information so that display generation unit **80** can process the converted information, producing a visual representation of a map depicting the waypoints along the prescribed route. Display generation unit **80** also receives from map data parser **79** the current position of subscriber unit **35**, as provided by position information parser **78**. As such, display generation unit **80** overlays the current position of subscriber unit **35** on the visual representation of the map. In other embodiments, destination information, traffic information, and weather information may be superimposed on the map.

Display generation unit **80** drives display unit **81**, which is an output device in navigation system **100**. In a car, display unit **81** may comprise a windshield heads-up display or dashboard-mounted LCD. In other embodiments of subscriber unit **35**, a compact LCD display may be integrated into a handheld assembly. Instead of displaying a map, display generation unit **80** may display in textual form a list of the instructions that a subscriber should follow along a route to an intended destination.

As shown in FIG. 3, subscriber unit **35** also includes speech processing portion **46**. Speech processing portion **46** comprises a speech processing input portion **46A** and a speech processing output portion **46B**.

Speech processing input portion **46A** comprises microphone **86**, speech recognition unit **85**, and speech command processor **84**. Microphone **86** is the interface between subscriber unit **35** and the spoken words of a subscriber. A subscriber speaks system commands into microphone **86**, and speech recognition unit **85** processes the commands. Speech recognition unit **85** recognizes individual speech elements, known in the art as phonemes or primitives. Speech command processor **84** assembles primitives received from speech recognition unit **85** into system commands that central processing and data storage unit **76** may act upon. For example, a subscriber may speak the words, "Route me from here to 111 N. Elm Street." Speech recognition unit **85** processes the primitives, and speech command processor **84** assembles the primitives such that subscriber unit **35** transmits current position information, destination information, and a request for corresponding navigation information to service provider **31**.

If different sets of speech primitives are stored in a nonvolatile memory that may be accessed by speech synthesis unit **82** and speech recognition unit **85**, subscriber unit **35** may support the recognition and synthesis of various languages. In such an embodiment, a subscriber may specify his native language. Subsequent interaction between the subscriber and subscriber unit **35** may proceed in this language. Because their patrons may be foreigners, car rental companies may derive special benefits from this embodiment.

In other embodiments, a particular subscriber may train speech command processor **84** and speech recognition unit **85** to more accurately recognize the subscriber's

speech. A training program may be run when a new subscriber uses subscriber unit **35** for the first time, or at an arbitrary time when the subscriber has sufficient time to provide a sampling of the subscriber's speech.

Speech processing output portion **46B** comprises speech synthesis unit **82** and speaker **83**. Speech synthesis unit **82** processes output messages from central processing and data storage unit **76** and synthesizes these output messages into recognizable speech patterns. These speech patterns are then outputted via speaker **83** in order to enable the subscriber in the vicinity of subscriber unit **35** to hear the output message. For example, speech synthesis unit may, by virtue of speaker **83**, generate the phrase: "You are off course. Please say 'reroute' and we will reroute you." In some embodiments, speech synthesis unit **82** may have a fixed vocabulary, but the vocabulary may be upgraded through periodic system updates. Upgrading of subscriber unit **35** could be accomplished by implementing EEPROM technology, such as, for example, flash memory and ferroelectric RAM devices.

FIG. 4 depicts the architecture of service provider **31**. Data transceiver **55** transmits and receives data in accordance with well known cellular communications technologies. Interfaced with data transceiver **55** is encryption/decryption processor **56**, which encrypts data before it is transmitted by data transceiver **55** to subscriber unit **35**, and decrypts data that is received from subscriber unit **35**. Encryption key database **57** stores encryption keys associated with various subscribers. It is to be noted that encryption key database **57** can reside in a remote location as well as within service provider **31**. Service provider **31** may store the current position of each subscriber unit **35** in a nonvolatile memory either locally or remotely.

Received message handler **58** processes messages received from subscriber unit **35** and validates their contents. If a message is valid, received message handler **58** routes the message to the appropriate service processor, including other service processors **59** and map information service processor **60**. Transmit message generator **61** transmits a received data acknowledgement parameter, whereby service provider **31** informs subscriber unit **35** that service provider **31** has successfully received data transmitted by subscriber unit **35**. If a message is invalid—for instance, the message is corrupted—received message handler **58** issues a retransmit request, which transmit message generator **61** sends to subscriber unit **35**. In the embodiment shown in FIG. 4, the retransmit request would be encrypted before transmission by encryption/decryption processor **56**.

When a valid message requesting navigation information is received by service provider **31**, map information service processor **60** processes the request. For example, if the subscriber has specified a destination to which the user wishes to navigate, map information service processor **60** gathers appropriate map data **62**, including graphical data and routing data, and transmit message generator **61** transmits the gathered data to subscriber unit **35** with the aid of encryption/decryption processor **56** and data transceiver **55**.

Map information service processor **60** may also monitor traffic conditions data **63** and weather conditions data **65** that are relevant to a given subscriber traversing a route and may take appropriate action if necessary, such as rerouting the subscriber to avoid a stretch of highway under construction or warning the subscriber to seek cover to avoid approaching severe weather. A subscriber may specify the telephone number of an intended destination instead of an address. As such, map information service processor **60**

accesses location/number database **64** to find the address associated with the telephone number.

Encryption in navigation system **100** may employ well known symmetric or asymmetric cryptographic methodologies. In the case of asymmetric methodologies, public and private keys may be generated the first time that a particular subscriber activates subscriber unit **35**. In some embodiments, such activation may occur at an activation facility, wherein an input/output port of subscriber unit **35** (not shown) receives configuration data from a configuration device connected to the input/output port of subscriber unit **35**. During activation, service provider **31** may receive subscriber-specific information inputted by the subscriber and transmitted by subscriber unit **35**, including subscriber name, address, telephone number, billing information, e-mail address, name of e-mail server, and userID and password for the e-mail server. It is to be appreciated that e-mail information need not be provided in certain embodiments.

Service provider **31** then generates a user identifier and a set of public and private keys that are unique to the subscriber. The subscriber's public key is stored in encryption key database **57** in service provider **31**. The subscriber's private key is programmed into a secure, nonvolatile memory in subscriber unit **35**, as is the public key of service provider **31**. Speech recognition unit **85** of subscriber unit **35** may optionally be configured to recognize the identity of a particular subscriber based on the subscriber's speech pattern and to associate the speech pattern with the subscriber's private encryption key. If multiple subscribers use a particular subscriber unit **35**, additional sets of keys may be generated and stored for each subscriber.

After the key sets are generated and stored, subscriber unit **35** and service provider **31** each encrypt data before transmission using the counterpart's public key. Under

normal operating conditions, a subscriber activates subscriber unit **35**, and speaks a predetermined word or phrase into microphone **86**. The identity of the subscriber is determined by means of speech recognition unit **85**, speech command processor **84**, and central processing and data storage unit **76**. Subscriber unit **35** then transmits a message to service provider **31** containing the subscriber's user identifier and indicating that subscriber unit **35** has been activated. Service provider **31** then accesses encryption key database **57** to locate the public key associated with the user identifier, and transmits a message in plaintext acknowledging the initial message of subscriber unit **35** and providing subscriber unit **35** with the public key of service provider **31**. After this handshaking procedure is complete, all subsequent messages transmitted by either service provider **31** or subscriber unit **35** are encrypted using the other party's public key and decrypted by the recipient using the recipient's private key.

In other embodiments, navigation system **100** may accommodate other services, such as, for example, e-mail access, World Wide Web (WWW) surfing, voicemail access, and emergency roadside assistance. For example, to access e-mail, a subscriber may speak a command such as "e-mail" into microphone **86**. Various modules of subscriber unit **35** described above process the spoken command and translate it into a specific message containing the subscriber's user identifier and a request to access e-mail. Mail service processor **69** (see FIG. 4) of service provider **31** uses the user identifier as a search key in subscriber information database **68**, retrieves the subscriber's e-mail address; the subscriber's e-mail service provider login information; and the system name/network address of the subscriber's e-mail service provider.

If e-mail server **66** of service provider **31** is not the subscriber's e-mail service provider, e-mail server **66** may act as a proxy, and connect and log into a third party e-mail

server that the subscriber had previously designated (not shown). If e-mail server **66** is that of the subscriber, the subscriber is logged in locally. Mail service processor **69** then scans the subscriber's inbox, returning the number of read and unread messages to subscriber unit **35**. The subscriber then retrieves messages via voice commands or other input devices, and views them on the display device **81**. Speech synthesis unit **82** may optionally read the e-mail messages to the subscriber.

Voicemail access may be effectuated in a manner similar to e-mail access, with voicemail server **67** acting as either the subscriber's voicemail server or a proxy to another such server. As shown in FIG. 3, speech processing input portion **46A** of subscriber unit **35** may include a speech recording unit **87**. The subscriber speaks into microphone **86**, and speech recording unit **87** records the subscriber's words so that an outgoing message may be forwarded to voicemail server **67**.

A subscriber communicating with service provider **31** may also surf the World Wide Web (WWW). For example, to access the WWW, a subscriber may speak a command such as "web" or "surf" into microphone **86**. Subscriber unit **35** then prompts the subscriber to speak the URL of the page to be retrieved. The above-described modules of subscriber unit **35** assemble the URL, which subscriber unit **35** sends to service provider **31** for processing via the Web service processor (not shown). The Web service processor sends the URL to the web page cache (not shown), which, acting as a proxy device, forwards the URL to the Internet. The web page cache then receives the web page from the Internet and transmits it to subscriber unit **35**. Subscriber unit **35** displays the web page on display unit **81**, and optionally plays speech in accordance with specific embedded speech tags. For instance, a web page may contain a tag that reads "Welcome

to yahoo.com." Web surfing may be performed by the subscriber via voice control or other input devices, such as a touch-sensitive screen, a keypad, or keyboard.

To summon emergency roadside assistance, a subscriber may speak a command such as "emergency" or "road service" into microphone **86**. Subscriber unit **35** then prompts the subscriber to specify what type of assistance is required, such as police, ambulance, or towing. A service request with appropriate parameters, including the subscriber's user identifier and current position, is transmitted to service provider **31**. Service provider **31** may transmit a message back to subscriber unit **35** to confirm that the request is valid. The subscriber validates the request, and subscriber unit **35** returns this validation to service provider **31**. Upon receiving the validation, service provider **31** alerts the appropriate authorities, providing all necessary information, including the subscriber's identity and current position. Finally, service provider **31** transmits a message to the subscriber confirming that help is on the way.

In another embodiment, subscriber unit **35** may include a two-layer software hierarchy that may be upgraded via cellular communications network **32**. The first layer may be firmware that controls low-level operations of subscriber unit **35**. The second layer may be application software associated with service provider **31** or other such service providers. An application programmatic interface (API) between the firmware and application software layers may be made available to the public by the manufacturer of subscriber unit **35**. As such, various service providers may write application software to run on subscriber unit **35**.

When subscriber unit **35** is manufactured, private keys for firmware and software may be stored in a nonvolatile memory of subscriber unit **35**. Service provider **31** stores the associated public keys. Service provider **31** may transmit a message to subscriber unit

35 when a firmware or software upgrade is available. Service provider **31** may use the public key for firmware to digitally sign firmware upgrades, and the public key for software to digitally sign software upgrades. Upgrades may then be transmitted to subscriber unit **35** in encrypted form via cellular communications network **32**, as described above. After decryption, subscriber unit **35** may authenticate the received upgrades using the private key for firmware, or the private key for software, as appropriate.

FIGs. 5, 6 are high-level flow diagrams depicting navigation process **500** in accordance with an embodiment of the present invention. As shown in FIG. 5, power is applied to subscriber unit **35** and communication is established between subscriber unit **35** and service provider **31** in block **B501**. In block **B502**, subscriber unit **35** acquires its current position via GPS mechanism **42**. Subscriber unit **35** then plays an audio prompt for the subscriber to specify a desired destination. The subscriber's speech input is received, and a speech recognition algorithm is performed. If the input is not understood, subscriber unit **35** plays an audio message that the input was not understood in block **B512**, and once again prompts the subscriber to enter a desired destination.

If the input is understood, then in block **B514**, central processing and data storage unit **76** determines whether map information encompassing the desired destination is stored locally. If such information is stored locally, subscriber unit **35**, in block **B516**, transmits its current location to service provider **31,** which then gathers and transmits routing information to route the subscriber from a current position to the desired destination. If such information is not in local storage, subscriber unit **35**, in block **B518**, transmits the inputted desired destination and current position to service provider **31**, which determines whether the destination is a valid destination. If the destination is invalid, subscriber unit **35** plays an audio message that the destination is invalid in block

B522, and prompts the subscriber to enter a desired destination. If the destination is valid, subscriber unit **35** receives initial map and routing data from service provider **31**, and in block **B601** of FIG. 6, stores the received information in nonvolatile local storage.

In block **B602**, subscriber unit **35** plays a message stating that navigation is ready to begin. In decision block **B604**, subscriber unit **35** monitors whether the subscriber has arrived at the inputted destination, and, if so, plays an audio message announcing that navigation is complete. If the inputted destination has not been reached, subscriber unit **35**, in block **B608**, plays audio queues which prompt the user to take action at various waypoints along the route. In block **B610**, position difference correlator **75** detects whether the subscriber has diverged from the prescribed route. If not, subscriber unit **35** proceeds to block **B612**. If so, subscriber unit **35**, in block **B614**, plays an audio prompt to alert the subscriber that the subscriber is off course. In block **B616**, subscriber unit **35** transmits its current position and a request for data to service provider **31**, which transmits new map and routing data to subscriber unit **35**, which loops back to block **B604**.

In block **B612**, position difference correlator **75** detects whether the subscriber is about to leave the geographical area covered by the map in local storage. If not, subscriber unit **35** proceeds to block **B604**. If the subscriber is about to leave that area, then additional graphical and routing data is needed from service provider **31**, and in block **B616**, subscriber unit **35** transmits its current position and a request for data. Service provider **31** transmits new map and routing data to subscriber unit **35**, which loops back to block **B604**. During navigation in FIGs. 5, 6, service provider **31** may preemptively notify the subscriber and alter a prescribed route (not shown) if the subscriber is approaching adverse traffic or weather conditions and may transmit such routing data to the subscriber.

The foregoing description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these embodiments are possible, and the generic principles presented herein may be applied to other embodiments as well. For example, the invention may be implemented in part or in whole as a hard-wired circuit, as a circuit configuration fabricated into an application-specific integrated circuit, or as a firmware program loaded into non-volatile storage or a software program loaded from or into a data storage medium as machine-readable code, such code being instructions executable by an array of logic elements such as a microprocessor or other digital signal processing unit.

As such, the present invention is not intended to be limited to the embodiments shown above but rather is to be accorded the widest scope consistent with the principles and novel features disclosed in any fashion herein.